

The Control of Bottom Rot of Lettuce

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A HARVESTED FIELD IN WHICH 62 PER CENT OF THE CROP HAS BEEN DESTROYED
BY BOTTOM ROT



Published by the
Cornell University Agricultural Experiment Station
Ithaca, New York

Received for publication December 31, 1931

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THE CONTROL OF BOTTOM ROT OF LETTUCE¹

G. R. TOWNSEND AND A. G. NEWHALL

THE CROP

About six thousand acres of Big Boston head lettuce are grown in New York State. The crop is grown chiefly on the muck soils of Oswego, Genesee, Orleans, Wayne, and Orange Counties. During its season, New York is second only to California, but throughout the year the State ranks fourth in the list of lettuce-producing States. New York outranks California in the eastern markets in July, August, and September. The value of this crop to the producers of our State varies from \$2,000,000 to \$3,000,000 annually.

The losses from bottom rot in this State constitute about 30 per cent of the crop annually. This means that 1800 acres of lettuce are grown with no return for labor, land, or fertilizer costs. In an average year the disease takes \$750,000 from the producers. Aside from this direct loss of a portion of the crop, a further loss results from the forced marketing of immature and low-quality lettuce. Many growers frequently find it advantageous to harvest lettuce which if allowed its proper growing period would be a total loss because of this disease. Consequently there are periods when the markets are glutted with inferior lettuce. The practice of marketing immature lettuce hinders the sale of good lettuce.

The growers expect heavy losses from bottom rot and therefore plant larger acreages of lettuce than the present system of marketing would warrant without these losses. Consequently, when they are so fortunate as to have a crop free from bottom rot the markets are flooded and prices decline. It may be said, therefore, that bottom rot is indirectly an important cause of the frequent overproduction of the crop. The element of uncertainty which it introduces is an important hazard of the industry.

VARIETAL SUSCEPTIBILITY

No variety of head lettuce has been found to be resistant, although the Cos, or Romaine, and Iceberg varieties usually escape the disease because of their more upright habit of growth. The White Boston variety is somewhat less affected than is the Big Boston variety.

THE DISEASE

SYMPTOMS

Bottom rot is a disease of the mature lettuce head. However, young plants are sometimes attacked during periods of weather favorable to the disease. The disease is characterized by the decay of the lower parts of the head, and, when severe, by the rotting of the entire head. At first

¹ This bulletin presents a preliminary account of the thesis material obtained by the senior author in his studies of bottom rot of lettuce. The work was conducted under the Oswego County Vegetable Growers' Association-Farm Bureau Fellowship in cooperation with the state investigation of muck-crop diseases being conducted by Dr. A. G. Newhall.

small rusty to chocolate brown spots appear on the undersides of the midribs of leaves touching the soil. The midribs and leaf blades are quickly rotted but the stem of the plant is more resistant. On bright warm days wilting of the outer wrapper leaves is one of the earliest symptoms seen from above. The decayed heads are at first brown and slimy, but as they dry out become almost black. Such mummied heads may be pulled from the stump of the plant. The irregular dark brown sclerotia (propagating organs) of the causal fungus are within the rotted heads, and the brown mold-like mycelium of the fungus also is in the heads and on the soil under the diseased plants.



FIGURE 1. BIG BOSTON LETTUCE UNFIT FOR MARKET BECAUSE OF BOTTOM ROT

It would be necessary to trim off so many outer leaves that almost no head would remain

There are three diseases which may be confused with bottom rot. One is the gray mold disease caused by a fungus (*Botrytis* sp.). This fungus is generally present as a dusty gray mold-like growth on the diseased parts. It forms irregular black sclerotia in the diseased tissues. Another disease is the lettuce drop which is a soft rot starting on the underside of the head and causing the collapse of the entire plant. The lesions in drop are softer than in bottom rot and are colorless. The cause of drop is the fungus *Sclerotinia sclerotiorum* which usually is conspicuous as a cottony white growth over the affected parts. It also forms dull black sclerotia in the affected tissues. A third disease similar to bottom rot is stem-girdle, the cause of which is not yet definitely known. It may be distinguished by the decay of the stem of the plant. The stem is rotted into shreds at the soil line.

CAUSE OF BOTTOM ROT

Bottom rot of lettuce is caused by the fungus *Rhizoctonia solani*, which is commonly found in many soils. Farmers are familiar with another strain of the fungus which produces the black flecks on their potato tubers and causes stem rot of the same crop. The flecks which occur on the tubers are the sclerotia. Similar but larger sclerotia are produced in the rotted heads of lettuce and go back into the soil with the crop refuse. When conditions are again favorable the sclerotia produce a new fungous growth ready to attack lettuce if it is then growing on that soil.

Because the parasitic fungus which causes the disease is a living plant, it is greatly affected by conditions of temperature and moisture. It makes its best growth in warm, humid weather. Prolonged drouth or very cool nights temporarily check the fungus. The disease is very destructive to the crop on infested soil when the mean temperature is above 67° F. during periods of ample moisture for crop growth. It may seem to the grower that the weather causes the rot. The weather, however, is of importance only because of its influence on the activity of the fungus. The disease cannot occur without the fungus. It is less severe on newly cleared lands because the fungus is less prevalent there.

CONTROL OF THE DISEASE

CULTURAL PRACTICES

A number of methods which have been tried have failed. For example, as shown in the unpublished notes of the junior author, breeding a type of head lettuce which stands away from the soil like Romaine did not prove successful.

From the experience of many growers it is apparent that long rotations do not control bottom rot.

Experiments conducted in three counties in 1930 showed that mulch paper is of little or no value in protecting the plants.

In other tests "fingering" the lettuce to stir and remove the surface soil beneath the head proved of no value. Some growers have used a type of cultivator known as "muck shoes" which performs the fingering operation. But this fails to control the rot satisfactorily.

The authors have shown by experiments on infested soils in several counties that variations in the use of fertilizers have no significant influence on the development of the disease; however, any factor which increases the growth rate will cause the disease to be slightly more destructive.

Two methods of partial control have been developed by growers and found of some value in tests made by the senior author. One is the removal of all the crop refuse by raking immediately after harvest. This carries away a great deal of the fungus and its food supply. The practice has been found more valuable when done just before a second crop is grown in the same season. It results in better stands and more rapid growth of seedlings. The second method of obtaining partial control is the use of green-manure crops. Oats ploughed under when about eight inches high reduced somewhat the amount of bottom rot in the next lettuce crop.

CONTROL WITH FUNGICIDES

The senior author has conducted field experiments with fungicides at Oswego, New York, yearly since 1928. Tests of many chemicals as soil treatments have demonstrated that the best control can be obtained with a 2-per-cent ethyl mercury phosphate dust (DuBay 738). When this is dusted under nearly mature plants one application of 20 to 25 pounds to the acre gives almost complete protection.

Although the dust can be applied by hand in garden plots, some mechanical device is necessary for the application of the chemical to large fields. In gardens the chemical may be shaken from a container which has small holes punched in its cover. Two types of hand dusters have been modified to meet the requirements for making applications in larger plantings

The bellows type of duster

A knapsack type of bellows duster can be employed successfully by using a Y attachment with curved pipes as illustrated in figure 2. By

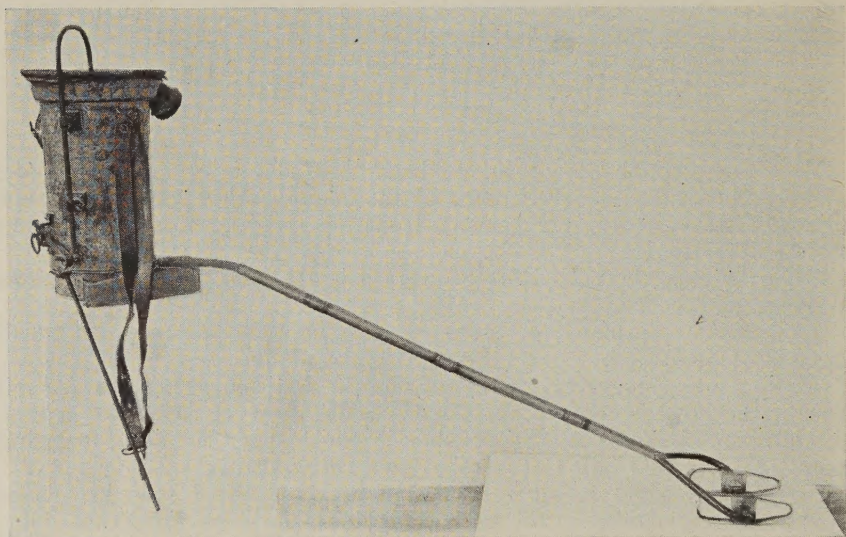


FIGURE 2. A SPECIAL NOZZLE ATTACHMENT FOR A BELLOWS, OR KNAPSACK, TYPE OF DUSTER, PERMITTING THE OPERATOR TO DIRECT THE DUST UNDER THE OUTER LEAVES

pushing or dragging these pipes along the ground on each side of the row the dust can be blown under each plant. About one-half acre can be treated in a day with this equipment. It is suitable for the few growers with small fields who may already own a knapsack duster. Those who do not or who have fields larger than a half acre in size will be better satisfied with a traction duster.

The traction duster

A very satisfactory machine can be made by mounting a blower gun or hand duster on bicycle or other wheels. The fan is driven by a chain from a sprocket on the axle. Special nozzles and leaf lifters have to be

constructed for directing the dust under the leaves. The machine is pushed like a hand cultivator. It has been found important to employ a type of duster which can be geared down to deliver smoothly a very small quantity of dust. In the experiments of 1931 the Root duster met these requirements, but there may be others equally satisfactory. With machines like those shown in figures 3, 4, and 5 it has been possible to treat two acres of lettuce in a day. Such dusters are expected to be on the market in another season.

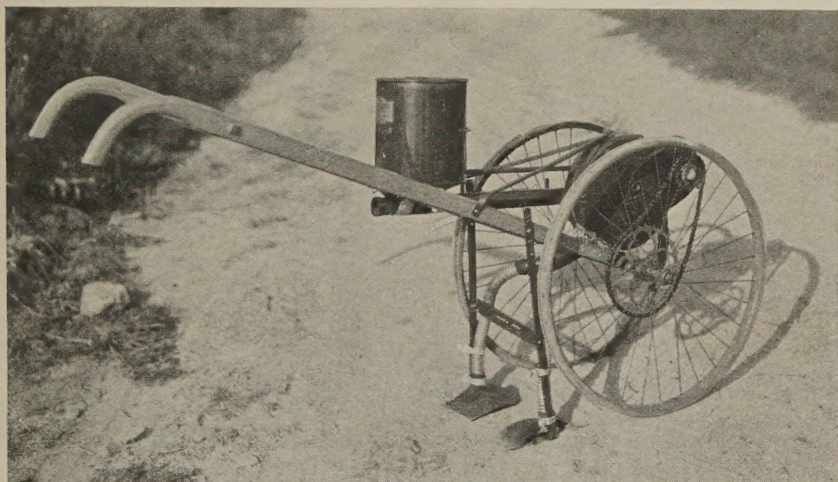


FIGURE 3. ONE OF THE EARLY MODELS OF TRACTION DUSTER MADE BY MOUNTING A PEERLESS DUST GUN ON BICYCLE WHEELS

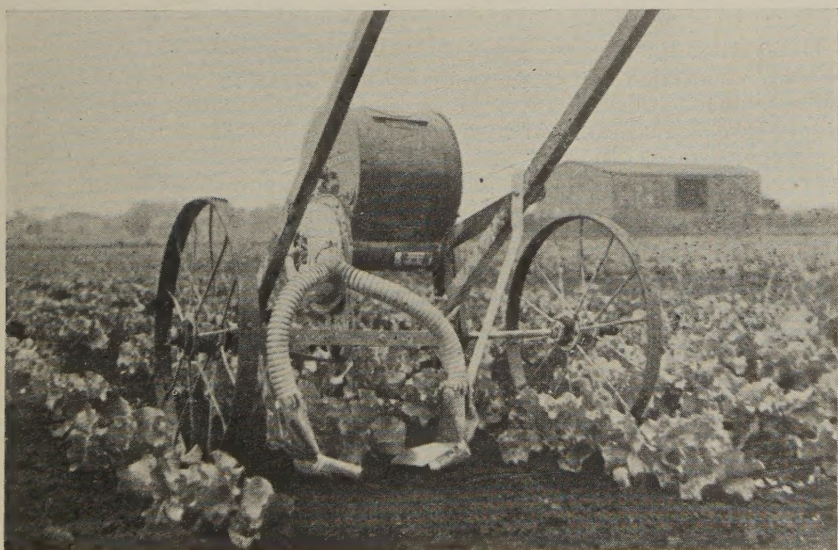


FIGURE 4. ANOTHER SUCCESSFUL MODEL EMPLOYING A ROOT DUSTER

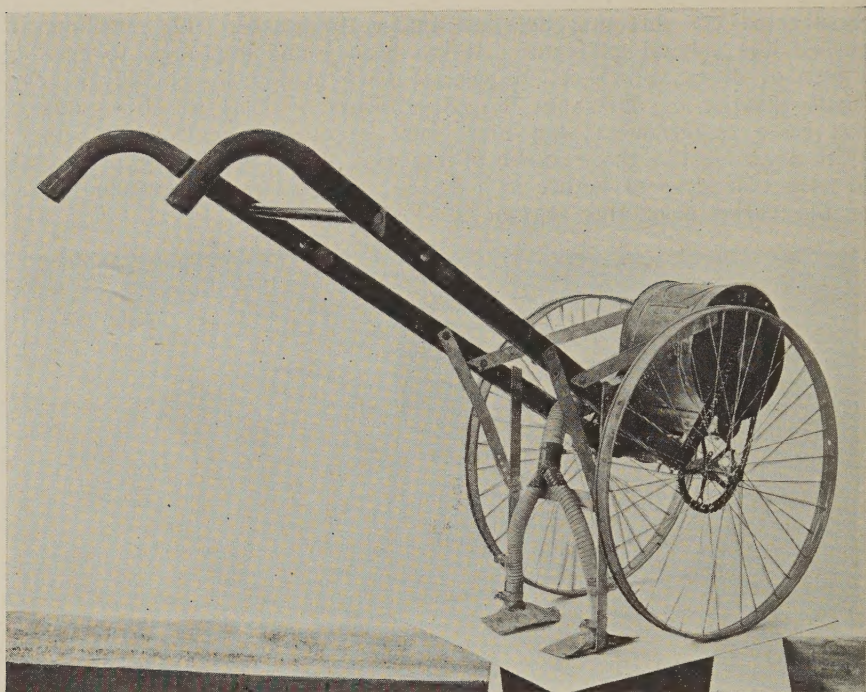


FIGURE 5. THE BEST MODEL DEVELOPED IN 1931, MADE BY MOUNTING A ROOT DUSTER ON BICYCLE WHEELS

This straddles one row of lettuce only

RESULTS OF FIELD EXPERIMENTS WITH TRACTION DUSTERS IN 1931

The traction dusters which are illustrated in figures 3 and 4 were used to apply the fungicides to more than thirty acres of lettuce in August and September, 1931. Records of the control of the disease were obtained in sixty-two fields. An untreated strip of six rows was left in each field for a comparison. In each case six hundred plants were examined and the percentage of disease was recorded. The counts showed that bottom rot was reduced from 22.6 per cent on the untreated rows to 2 per cent on the treated rows. The records of yields which were obtained in forty-nine fields showed an average increase of 180 crates per acre for the treatment. The control of the disease also resulted in the production of heavier lettuce of higher quality than was produced on the untreated rows.

The data in table 1 illustrate what may be expected from an application of twelve to thirty-three pounds per acre of DuBay 738. These applications were made from seven to seventeen days before the crop was mature.

TABLE 1. DATA ILLUSTRATING BOTTOM-ROT CONTROL FROM ONE APPLICATION OF ETHYL MERCURY PHOSPHATE (DU BAY 738) APPLIED WITH A TRACTION DUSTER

Field no.	Pounds of Du Bay 738 used per acre	Days from treatment to harvest	Per cent of bottom rot in 600 plants at harvest	
			Untreated	Treated
1.....	27	14	28.6	1.8
2.....	22	7	29.0	1.7
3.....	18	10	18.5	0.3
4.....	32	12	11.8	0.6
5.....	27	13	30.8	2.6
6.....	21	13	34.8	4.3
7.....	30	9	13.0	0.3
8.....	26	12	16.6	1.6
9.....	22	9	9.6	2.0
10.....	21	16	14.6	0
11.....	33	15	37.0	0.8
12.....	22	12	52.5	4.3
13.....	23	13	45.0	1.3
14.....	29	13	36.6	6.3
15.....	20	11	41.5	1.1
16.....	21	14	14.3	1.6
17.....	12	17	23.8	2.8
18.....	20	13	33.1	0.6
19.....	27	14	67.5	2.8
20.....	30	12	42.1	4.3
Average for 20 fields.....	24	12	30.0	2.0

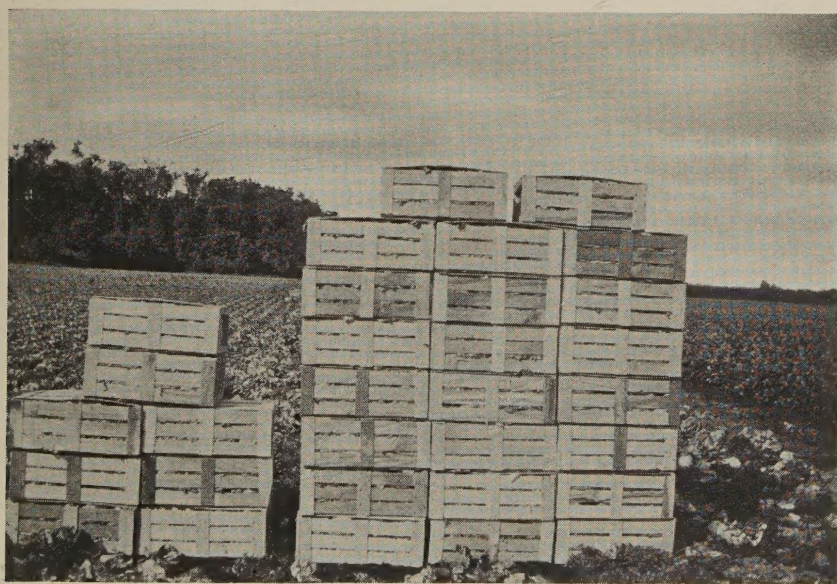


FIGURE 6. YIELDS FROM A TREATED AND CHECK PLOT OF EQUAL SIZE (1/30 ACRE)
In this field the yield was increased by 630 crates to the acre

USE OF THE FUNGICIDE

It is necessary to observe a few rules and precautions if the best results are to be obtained with this treatment.

1. The rate of application is low. It is recommended that not more than twenty to twenty-five pounds of DuBay 728 be used to the acre.

An application as low as twelve pounds an acre may give control (table 1). An application above thirty-five pounds an acre may injure the crop. The amount of the fungicide applied should be measured carefully.

2. The application should be correctly timed. The best time to make the application is just before the disease is liable to appear. Observations made during the progress of these experiments indicate that usually this is two weeks before the crop is mature. It should not be used more than three weeks before the maturity of the crop. Neither is the treatment of full value if it is made after a considerable amount of disease is present in the field.

Sometimes a difference of only a day or two in the time of application makes a difference in the degree of control obtained. This is illustrated in table 2 which shows the effect of delaying the application on half of two fields for only twenty-four hours during a period of great activity on the part of the fungus.

TABLE 2. EFFECT OF TIMELY AND DELAYED TREATMENTS AT TIMES WHEN THE DISEASE IS DEVELOPING RAPIDLY

Field no.	Per cent of heads affected at harvest time		
	Timed correctly	24 hours late	No treatment
1.....	1.7	9	29
2.....	0.5	5	42

Distribution is better when the plants and soil are dry. Whenever possible, dusting lettuce when the foliage is wet from heavy dews or rain should be avoided. It is preferable to dust before rainy periods rather than after them.

3. Thoroughness is essential. It is very important that the dust should be blown well under the plants and against the stem. If the dust is improperly distributed its application is a waste of time and money. The objective is to lay a fine film of dust over the entire soil surface under the plant. The small quantity of dust used is barely visible on the soil after the application.

4. It is best not to cultivate after dusting. The soil under the plants should not be disturbed after the application has been made. The fungicide cannot protect the plant if fresh soil is brought into contact with the leaves.

5. The use of fillers is optional. It is sometimes an aid in obtaining better distribution if the chemical is mixed thoroughly with some inert material. For this purpose two parts, by weight, of Bentonite clay, hydrated lime, or sifted dry muck can be mixed with one part of the chemical. The application of such a mixture must be three times as heavy as that of the unmixed chemical. With the best type of traction duster it is not necessary to use a filler.

6. Care is needed in choice of operators. The person who applies the dust should understand clearly the purpose of the treatment and should be instructed in the proper use of the machine. If possible one man should be trained for this work.

7. The chemical is poisonous. The fumes of DuBay 738 should not be inhaled because some persons are nauseated by them. The container should be kept tightly covered when not in use. When dusting it is best to travel across the wind. Some persons require a mask or handkerchief over the nose and mouth.

The possibility of persons who consume the lettuce being poisoned by ethyl mercury phosphate has been considered. Chemical tests were made on lettuce cut from treated fields and no mercury could be detected on them.² This was true even when only the lower leaves were used for the analysis. The application is so light that the trimming incident to packing the lettuce is sufficient to remove all traces of the fungicide, so there need be no fear that persons will be poisoned by eating any quantity of lettuce from dusted fields.

COST OF CONTROLLING BOTTOM ROT

The cost of this treatment should not exceed \$15 an acre. The charges may be itemized as follows:

25 pounds ethyl mercury phosphate (DuBay 738).	\$12.50
5 hours labor	2.00
Use of equipment	.50
Total	\$15.00

The cost of the treatment is so small in relation to the returns which are obtained that the protection of the crop by dusting should prove a highly profitable procedure on all farms where heavy losses from bottom rot occur.

SUMMARY

Bottom rot of lettuce causes an annual loss of 30 per cent of the New York State crop on muck soils.

The symptoms of the disease are described.

Bottom rot is caused by the fungus *Rhizoctonia solani*.

Warm humid weather is necessary for the greatest development of this disease.

Very satisfactory control has been obtained by one application of an ethyl mercury phosphate dust (DuBay 738).

Traction dusters have been developed for applying the fungicide.

An average increase in yield of 180 crates to the acre has been obtained.

The cost of the treatment does not exceed \$15 an acre.

² Tests made by a chemist of the Du Pont Company, Wilmington, Delaware.

